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(54) **PERIPHERAL CIRCUIT OF TOUCH PANEL AND MANUFACTURING METHOD THEREOF**

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CPC ***H05K 3/1283*** (2013.01); ***G06F 3/041*** (2013.01); ***G06F 3/044*** (2013.01); ***G06F 3/045*** (2013.01); ***H05K 1/0296*** (2013.01); ***H05K 3/02*** (2013.01); *G06F 2203/04103* (2013.01); *H05K 1/092* (2013.01); *H05K 2203/0514* (2013.01); *H05K 2203/1131* (2013.01); *H05K 2203/1476* (2013.01)

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,542,374	B1 *	4/2003	Muramatsu et al.	361/760
7,710,400	B2 *	5/2010	Yamada et al.	345/173

(Continued)

FOREIGN PATENT DOCUMENTS

CN	101996007	A	3/2011
CN	102300414	A	12/2011

(Continued)

OTHER PUBLICATIONS

Office action mailed on Sep. 23, 2013 for the Taiwan application No. 101113236, filing date: Apr. 13, 2012, p. 1 line 12~14, p. 2~6 and p. 7 line 1~24.

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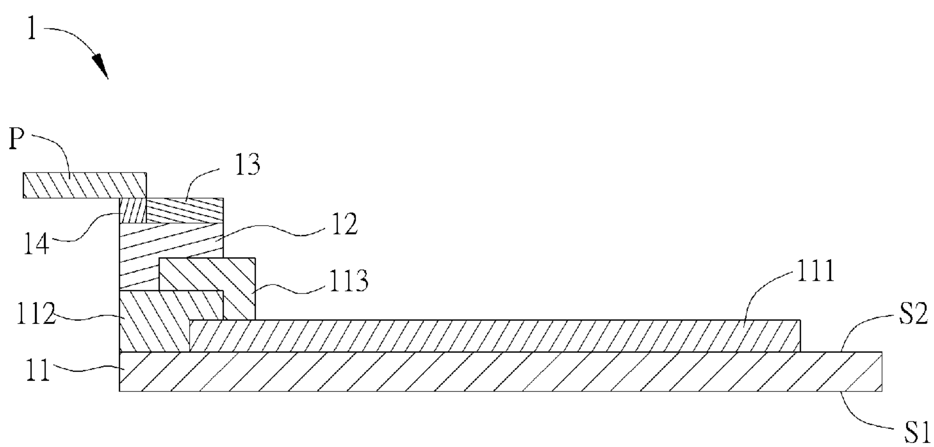
(57) **ABSTRACT**

A method for manufacturing a peripheral circuit of a touch panel includes: printing a radiation curable conductive material on a substrate having a transparent conductive pattern; irradiating the radiation curable conductive material with a radiated ray, in order to cure parts of the radiation curable conductive material; and removing uncured parts of the radiation curable conductive material, in order to form the peripheral circuit.

4 Claims, 12 Drawing Sheets



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H05K 1/09 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,868,957	B2 *	1/2011	Yamazaki et al.	349/43
8,427,446	B2	4/2013	Lan	
2001/0024184	A1 *	9/2001	Maeda	345/87
2001/0043291	A1 *	11/2001	Kono et al.	349/12
2002/0000979	A1 *	1/2002	Furuhashi et al.	345/173
2002/0005928	A1 *	1/2002	Hanakawa et al.	349/149
2002/0008681	A1 *	1/2002	Hanakawa et al.	345/87
2002/0008815	A1 *	1/2002	Hanakawa et al.	349/113
2002/0054261	A1 *	5/2002	Sekiguchi	349/122
2002/0101409	A1 *	8/2002	Yokoyama et al.	345/173
2002/0118325	A1 *	8/2002	Hinata et al.	349/113
2002/0146874	A1 *	10/2002	Kawasaki et al.	438/166
2003/0071796	A1 *	4/2003	Nakanishi et al.	345/173
2003/0201985	A1 *	10/2003	Katakami	345/173
2004/0009303	A1 *	1/2004	Ito et al.	427/421
2004/0092061	A1 *	5/2004	Kawasaki et al.	438/166
2004/0241344	A1 *	12/2004	Kawanishi et al.	428/1.1
2005/0046622	A1 *	3/2005	Nakanishi et al.	345/173
2005/0095356	A1 *	5/2005	Nakamura et al.	427/58
2006/0132450	A1 *	6/2006	Yamada et al.	345/173
2006/0202638	A1 *	9/2006	Kubota et al.	315/291
2006/0236917	A1 *	10/2006	Denda	117/60
2007/0013678	A1 *	1/2007	Nakajima et al.	345/174
2007/0085112	A1 *	4/2007	Yamazaki et al.	257/288
2007/0218957	A1 *	9/2007	Nishikawa et al.	455/566
2008/0020202	A1 *	1/2008	Nashiki et al.	428/337
2008/0122802	A1 *	5/2008	Furuhashi et al.	345/174
2009/0231301	A1 *	9/2009	Chang et al.	345/174
2009/0284484	A1 *	11/2009	Hwang et al.	345/173
2010/0001975	A1 *	1/2010	Jiang et al.	345/174
2010/0003502	A1 *	1/2010	Nashiki et al.	428/328
2010/0013784	A1 *	1/2010	Nashiki et al.	345/173
2010/0015417	A1 *	1/2010	Nakajima et al.	428/195.1
2010/0048254	A1 *	2/2010	Jiang et al.	455/566
2010/0182524	A1 *	7/2010	Nomura	349/40
2010/0200875	A1 *	8/2010	Takei	257/91
2010/0283755	A1 *	11/2010	Hsih	345/174
2011/0012865	A1 *	1/2011	Nozawa	345/174
2011/0097834	A1 *	4/2011	Yamazaki et al.	438/30
2011/0102343	A1 *	5/2011	Imai et al.	345/173
2011/0115738	A1 *	5/2011	Suzuki et al.	345/173
2011/0141065	A1 *	6/2011	Noguchi et al.	345/176
2011/0217548	A1 *	9/2011	Nashiki et al.	428/339
2011/0221702	A1 *	9/2011	Tanaami	345/174
2011/0227846	A1 *	9/2011	Imazeki	345/173
2011/0234520	A1 *	9/2011	Chan	345/173
2011/0242023	A1 *	10/2011	Lee	345/173
2011/0255227	A1 *	10/2011	Murakami	361/679.01
2011/0260741	A1 *	10/2011	Weaver et al.	324/686
2011/0304564	A1 *	12/2011	Kim et al.	345/173
2012/0044662	A1 *	2/2012	Kim et al.	361/816
2012/0075214	A1 *	3/2012	Kim	345/173
2012/0075237	A1 *	3/2012	Ikeda et al.	345/174
2012/0081333	A1 *	4/2012	Ozeki et al.	345/174
2012/0111718	A1 *	5/2012	Haishi et al.	204/192.1
2012/0114923	A1 *	5/2012	Haishi et al.	428/213
2012/0139829	A1 *	6/2012	Anno et al.	345/156
2012/0146942	A1 *	6/2012	Kamoshida et al.	345/174
2012/0293298	A1 *	11/2012	Nakamura et al.	338/211

FOREIGN PATENT DOCUMENTS

CN	102311681 A	1/2012
TW	201209656	3/2012
TW	201214032 A1	4/2012

* cited by examiner

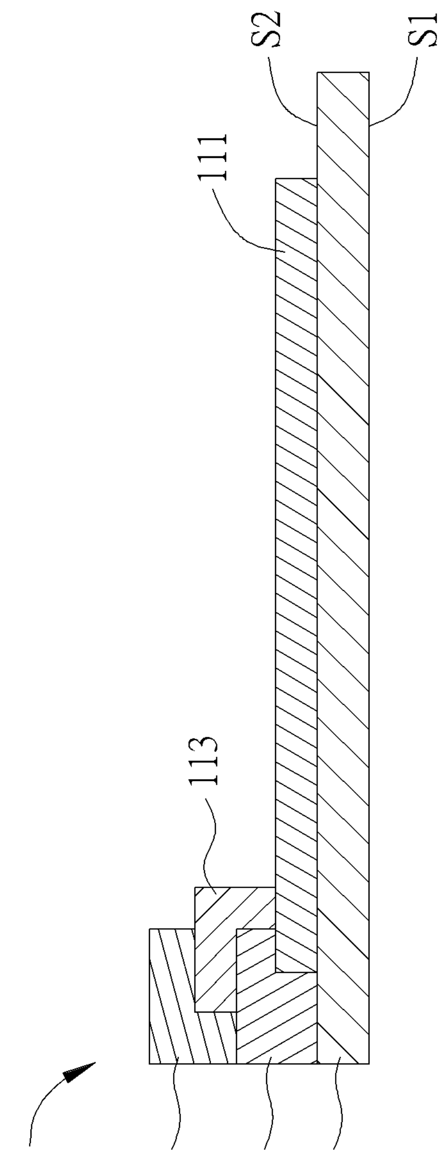

FIG. 1A

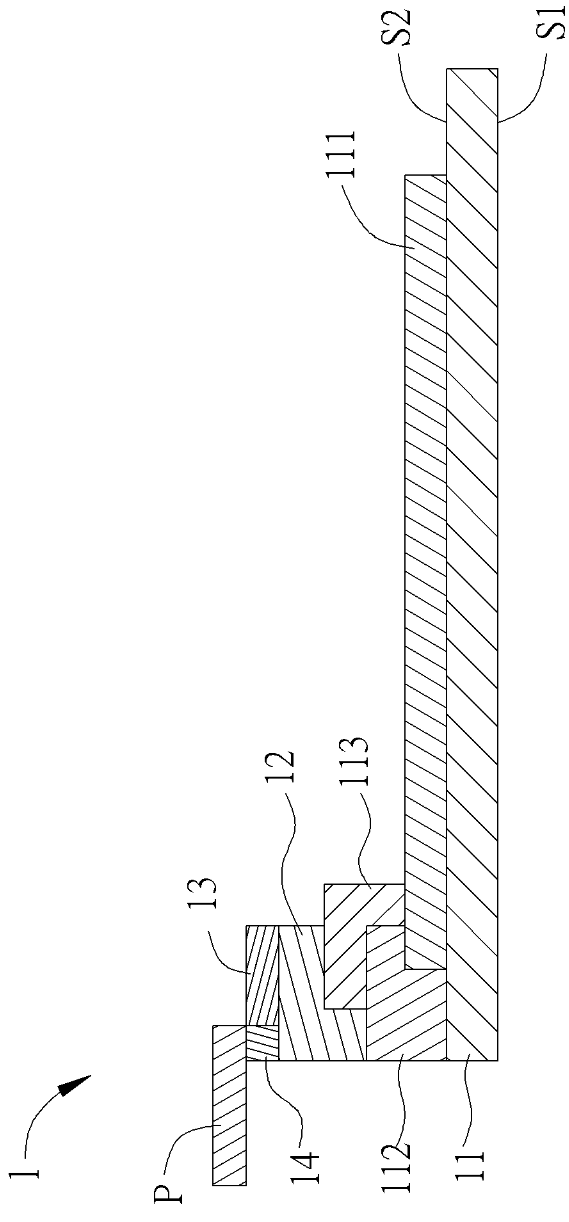

FIG. 1B

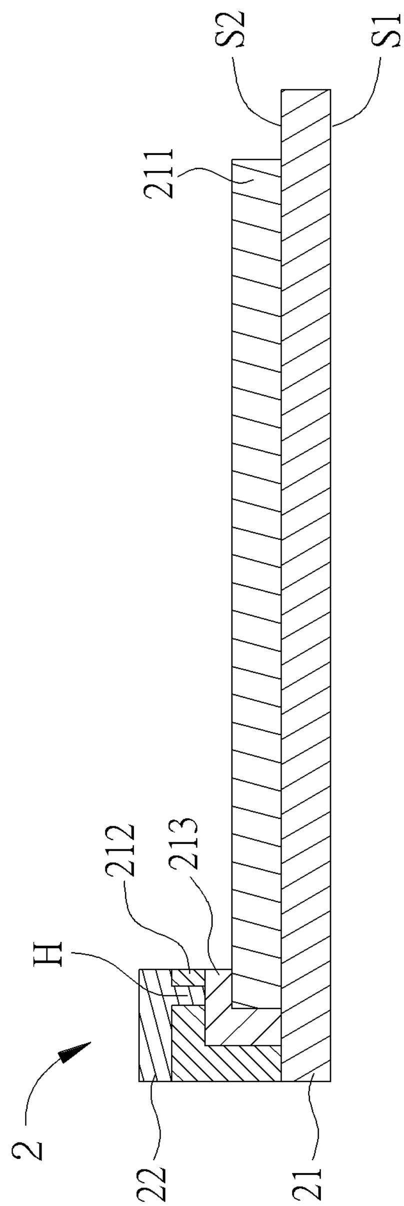

FIG. 2A

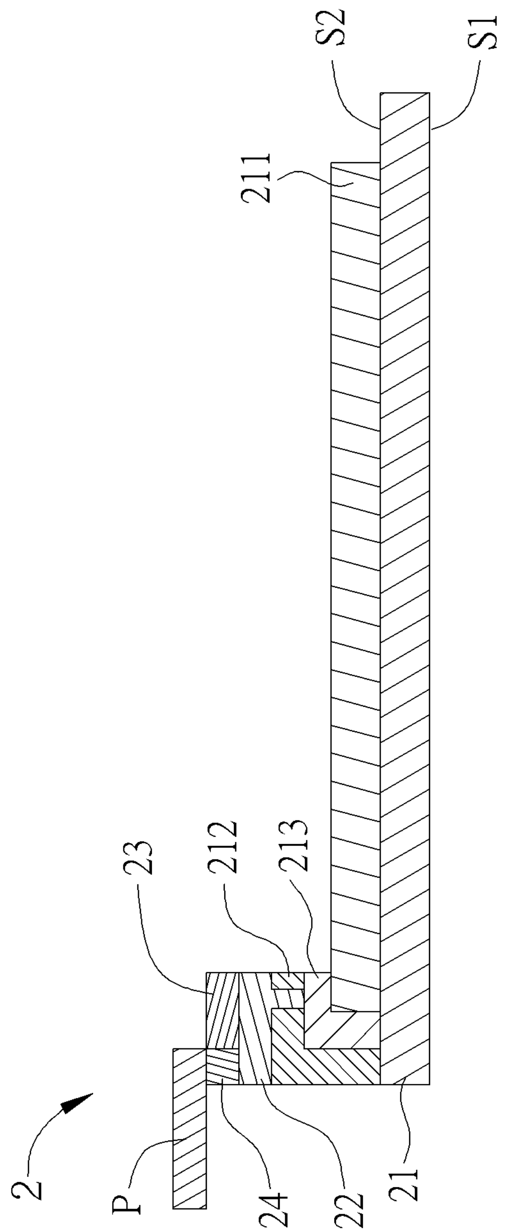

FIG. 2B

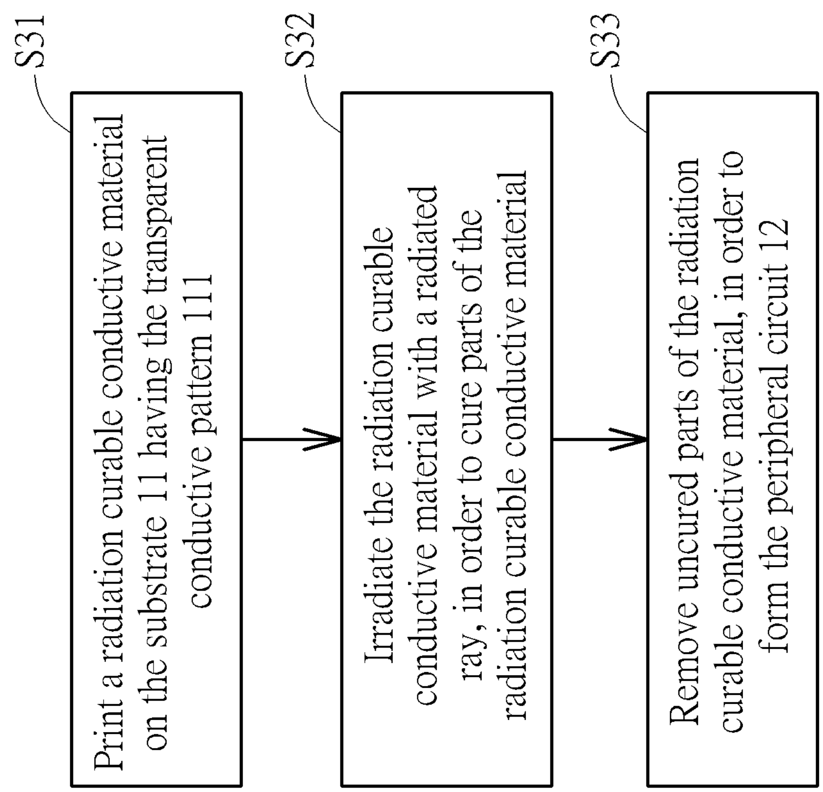
S31
Print a radiation curable conductive material on the substrate 11 having the transparent conductive pattern 111
S32
Irradiate the radiation curable conductive material with a radiated ray, in order to cure parts of the radiation curable conductive material
S33
Remove uncured parts of the radiation curable conductive material, in order to form the peripheral circuit 12

FIG. 3

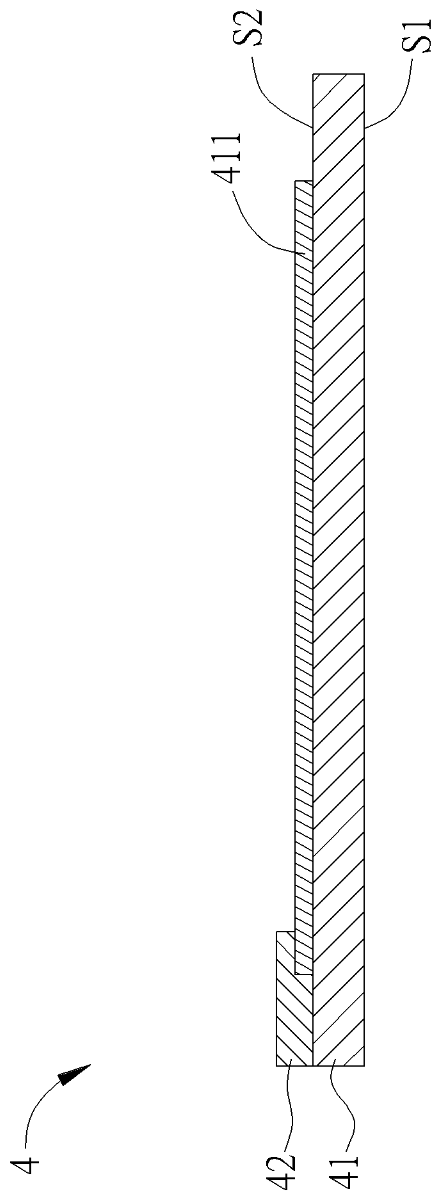

FIG. 4A

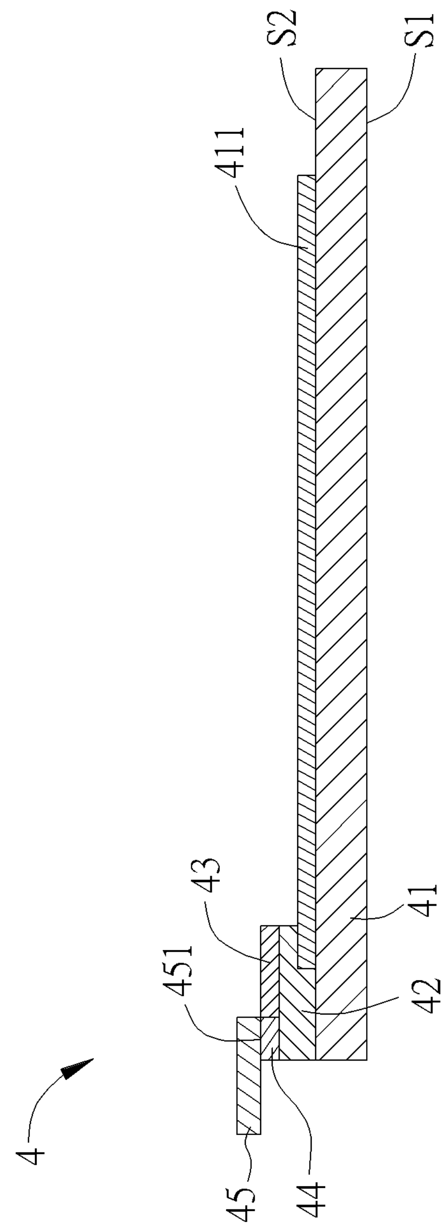

FIG. 4B

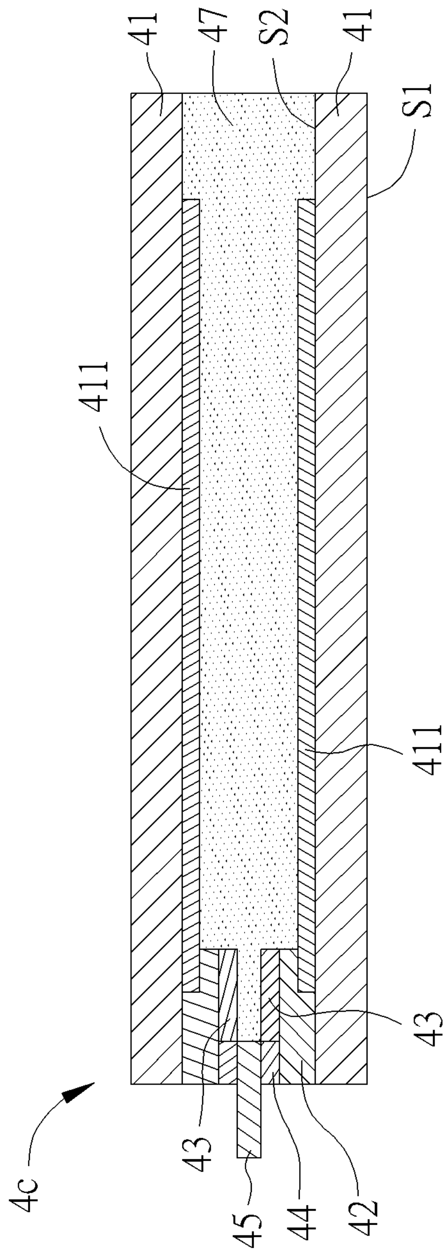

FIG. 4C

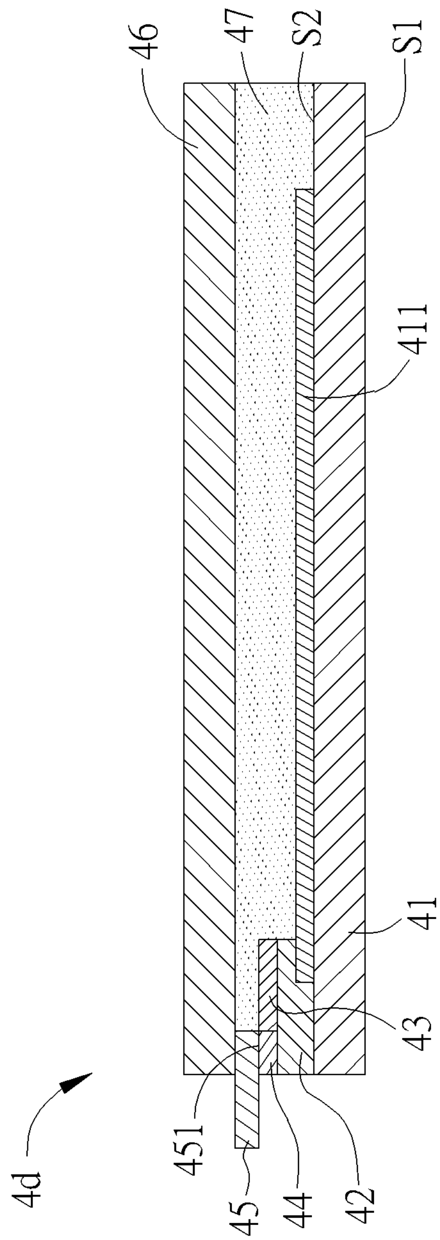

FIG. 4D

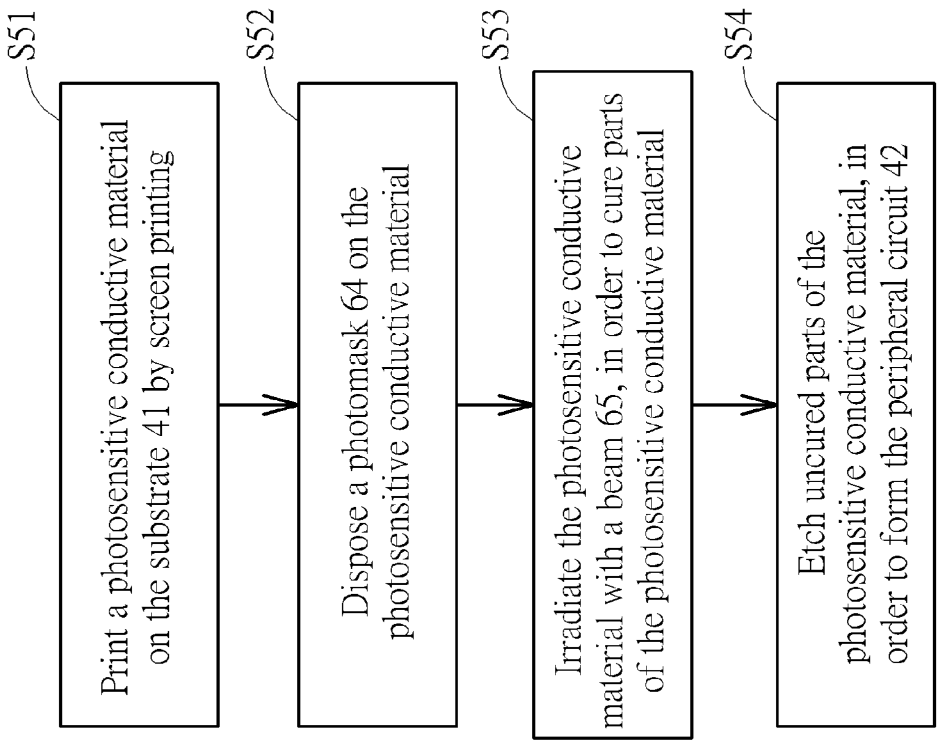
S51
Print a photosensitive conductive material on the substrate 41 by screen printing
S52
Dispose a photomask 64 on the photosensitive conductive material
S53
Irradiate the photosensitive conductive material with a beam 65, in order to cure parts of the photosensitive conductive material
S54
Etch uncured parts of the photosensitive conductive material, in order to form the peripheral circuit 42

FIG. 5

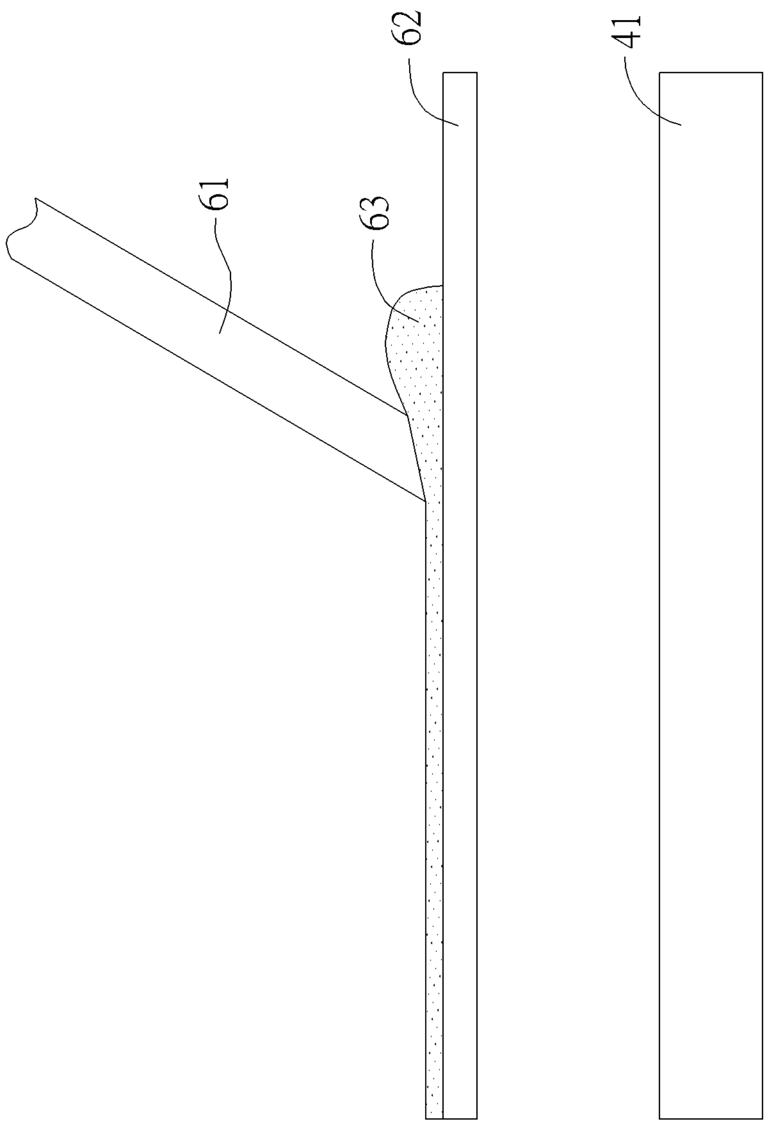

FIG. 6A

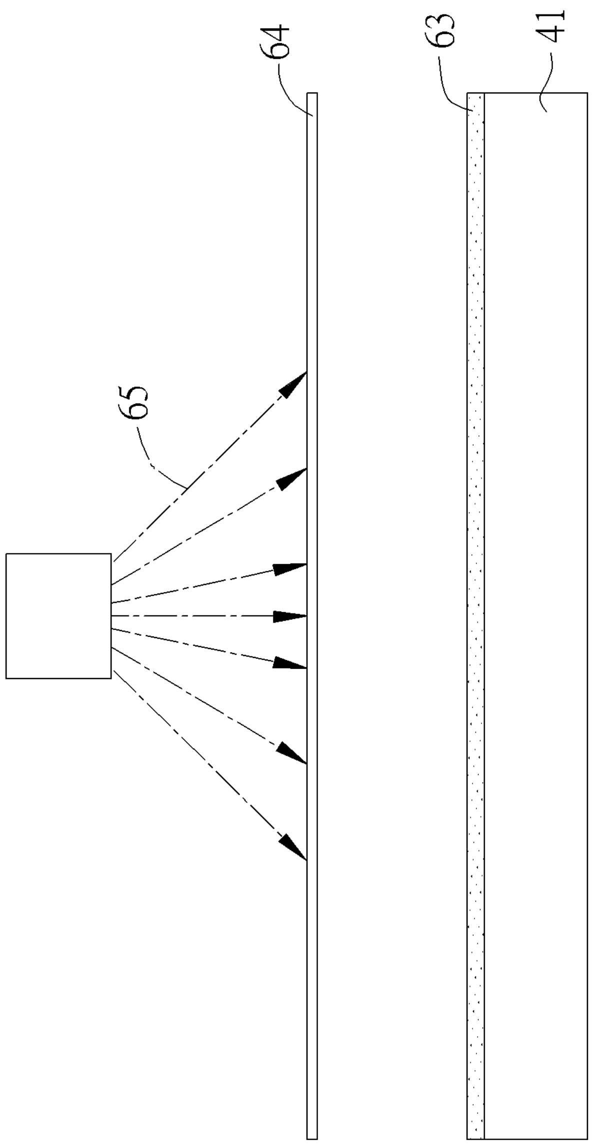

FIG. 6B

PERIPHERAL CIRCUIT OF TOUCH PANEL AND MANUFACTURING METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a peripheral circuit of a touch panel and a manufacturing method thereof.

2. Description of the Prior Art

Various types of touch technology are widely applied in electronic products. For example, in mobile phones and tablets, touch panels are often utilized as an input interface. The user can use their hand to directly contact the surface of the touch panel for performing operations, or slide their hand on the surface of the touch panel to control a mouse or perform a hand-written input. A display together with the touch panel may also show a virtual keyboard for the user, and the user can input characters via corresponding keys on the virtual keyboard.

The touch panel may be divided into various types such as a resistive touch panel, capacitive touch panel, ultrasonic touch panel and infrared ray touch panel. Among these touch panels, the resistive touch panel is the most commonly utilized. The resistive touch panel may mainly be divided into a four-wire touch panel, five-wire touch panel, six-wire touch panel and eight-wire touch panel. Since the four-wire touch panel is more mature in consideration of cost and technology, it is currently the most widely manufactured. The capacitive touch panel, however, can sense a light-touch, and thus is more convenient for utilization. In addition, the capacitive touch panel rarely wears down due to finger contact. It is also more stable and has a longer life than the resistive touch panel. For these reasons, the capacitive touch panel is gradually replacing the resistive touch panel as the most commonly utilized touch panel applied in electronic products.

The touch panel includes a substrate, a transparent conductive layer formed on the substrate, a peripheral circuit and an insulating layer. The touch panel may further include a connected flexible printed circuit board (FPC). The peripheral circuit is connected with the transparent conductive layer and the FPC. The peripheral circuit can be formed by a photolithography process. The conventional photolithography process includes the following steps: first, a metal layer is formed on the substrate by deposition or electrode planting; then a photoresist layer is applied on the metal layer, and selective exposure is performed on the photoresist layer; then developing is performed on the photoresist layer after exposure with a developer, to obtain a patterned photoresist layer; finally, the patterned photoresist layer is utilized as a mask to etch the metal layer, in order to form a conductive circuit on the substrate.

When the conventional photolithography process is implemented, the steps are complex and need to utilize a large number of chemicals, such that the cost is high and the process may not comply with the requirements and trends of environmental protection emphasized in modern science and technology.

In order to solve the problems of manufacturing the peripheral circuit with the conventional photolithography process, the industry provides a manufacturing method for forming the peripheral circuit with a printing process. This method prints a thermal setting conductive adhesive on the substrate, and then cures and bakes the thermal setting conductive adhesive with a high temperature, in order to form the peripheral circuit. This manufacturing method benefits from a simplified process in comparison to the photolithography process, but

the peripheral circuit formed by utilizing the printing process may come off since the adherence degree of the printing ink connected with the substrate is low, which causes the conductive circuit to be cut off. In addition, this method may only be applied in a conductive pattern and circuit with a thicker wire width and a greater wire distance, and cannot effectively enhance the density of circuit disposition.

Therefore, how to provide a peripheral circuit of a touch panel and a manufacturing method thereof which are capable of reducing wire width or wire distance in order to achieve higher integration while complying with environmental protection requirements becomes an important issue.

SUMMARY OF THE INVENTION

It is an objective of the present invention to provide a peripheral circuit of a touch panel that can be manufactured using a simplified process while maintaining the adherence degree and electronic characteristics, and a manufacturing method thereof, which can reduce wire width or wire distance in order to achieve higher integration while complying with environmental protection requirements.

In order to achieve the above objectives, a method of manufacturing a peripheral circuit of a touch panel according to the present invention comprises the following steps: printing a radiation curable conductive material on a substrate having a transparent conductive pattern; irradiating the radiation curable conductive material with a radiated ray, in order to cure parts of the radiation curable conductive material; and removing uncured parts of the radiation curable conductive material, in order to form the peripheral circuit.

According to an embodiment of the present invention, a wavelength of the radiated ray is approximately within a range from 230 nanometers to 600 nanometers.

According to an embodiment of the present invention, the transparent conductive pattern is connected with the peripheral circuit.

According to an embodiment of the present invention, a wire width of the peripheral circuit is less than or equal to about 70 micrometers.

According to an embodiment of the present invention, the radiation curable conductive material comprises radiation curable silver glue, radiation curable silver paste or radiation curable ink.

According to an embodiment of the present invention, the step of curing parts of the radiation curable conductive material comprises selectively curing the radiation curable conductive material by disposing a photomask on the radiation curable conductive material, wherein a material of the photomask comprises glass, quartz or polyethylene terephthalate (PET).

According to an embodiment of the present invention, the radiated ray irradiates the radiation curable conductive material with at least two different wavelength ranges.

According to an embodiment of the present invention, the radiation curable conductive material is printed on the substrate by screen printing.

According to an embodiment of the present invention, the substrate is a transparent plastic substrate, a transparent glass substrate or a PET thin film substrate.

In order to achieve the above objectives, a touch panel according to the present invention comprises a substrate and a peripheral circuit. The substrate has a transparent conductive pattern. The peripheral circuit is connected with the transparent conductive pattern. A material of the peripheral circuit comprises a radiation curable conductive material.

According to an embodiment of the present invention, a wire width of the peripheral circuit is less than or equal to about 70 micrometers.

According to an embodiment of the present invention, the radiation curable conductive material comprises radiation curable silver glue, radiation curable silver paste or radiation curable ink.

According to an embodiment of the present invention, the substrate is a transparent plastic substrate, a transparent glass substrate or a PET thin film substrate.

In order to achieve the above objectives, a peripheral circuit of a touch panel according to the present invention is manufactured using the above methods.

In order to achieve the above objectives, a method of manufacturing a peripheral circuit of another touch panel according to the present invention comprises the following steps: printing a photosensitive conductive material on a substrate by screen printing; disposing a photomask on the photosensitive conductive material; irradiating the photosensitive conductive material with a beam, in order to cure parts of the photosensitive conductive material; and etching uncured parts of the photosensitive conductive material, in order to form the peripheral circuit.

According to an embodiment of the present invention, the substrate is a transparent substrate.

According to an embodiment of the present invention, the photosensitive conductive material comprises a plurality of silver particles, and a diameter of the plurality of silver particles is within a range from 1 micrometer to 10 micrometers.

According to an embodiment of the present invention, a wire width of the peripheral circuit is less than 100 micrometers.

According to an embodiment of the present invention, a material of the photomask comprises glass, quartz or PET.

According to an embodiment of the present invention, the step of etching is performed by wet etching.

According to an embodiment of the present invention, the method further comprises connecting the peripheral circuit with a flexible printed circuit board (FPC) by using a conductive adhesive.

According to an embodiment of the present invention, the conductive adhesive is an anisotropic conductive film (ACF) or anisotropic conductive paste (ACP).

According to an embodiment of the present invention, the method further comprises disposing a protective film on the peripheral circuit.

According to an embodiment of the present invention, the step of disposing the protective film on the peripheral circuit comprises disposing the protective film utilizing a pasting method or a printing method.

According to an embodiment of the present invention, the beam comprises a visible light with a wavelength within a range from 350 micrometers to 780 micrometers.

As mentioned above, the peripheral circuit of the touch panel and the manufacturing method thereof according to one exemplary embodiment of the present invention utilizes radiation curable conductive material as a printing material to be printed on the substrate, cures parts of the radiation curable conductive material, and then removes uncured parts of the radiation curable conductive material in order to form the peripheral circuit. These steps can realize the reduction of wire width or wire distance in order to achieve higher integration while complying with environmental protection requirements. The peripheral circuit of the touch panel and the manufacturing method thereof according to another exemplary embodiment of the present invention utilizes photosensitive conductive material as a printing material to be printed on the substrate, cures parts of the photosensitive conductive material, and then etches uncured parts of the photosensitive conductive material in order to form the peripheral circuit. These steps can realize the simplification of the manufacturing process while retaining the adherence degree and electronic characteristics. For the implementation of the present invention, the manufacturing method enjoys the benefits of screen printing and exposure/development; hence power consumption problems can be avoided, as opposed to the conventional thermal curing process where the power consumption is generated by using an oven for a long time. Therefore, the environmental protection requirements can also be met.

In summary, the peripheral circuit of the touch panel and the manufacturing method thereof according to the present invention enjoy the benefits of screen printing and exposure/development, which not only can manufacture the touch panel at a low cost and high speed, but can also provide the touch panel with the advantages of small wire width and wire distance. This method is therefore suitable for smaller electronic devices. The peripheral circuit of the touch panel and the manufacturing method thereof according to the present invention can enlarge the visible area, which provides greater convenience for the user.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A and FIG. **1**B are schematic diagrams of a touch panel according to a preferable embodiment of the present invention.

FIG. **2**A and FIG. **2**B are schematic diagrams of another touch panel according to a preferable embodiment of the present invention.

FIG. **3** is a block diagram of a method of manufacturing the peripheral circuit of the touch panel according to a preferable embodiment of the present invention.

FIG. **4**A to FIG. **4**D are schematic diagrams of another touch panel according to a preferable embodiment of the present invention.

FIG. **5** is a block diagram of a method of manufacturing the peripheral circuit of the touch panel according to a preferable embodiment of the present invention.

FIG. **6**A and FIG. **6**B are schematic diagrams of another touch panel according to a preferable embodiment of the present invention.

DETAILED DESCRIPTION

In the following, the description refers to illustrations related to a peripheral circuit of a touch panel and a manufacturing method thereof according to preferable embodiments of the present invention, where the same elements are denoted by the same reference symbols.

Please refer to FIG. **1**A and FIG. **1**B, which are schematic diagrams of a touch panel **1** according to a preferable embodiment of the present invention. The touch panel **1** includes a substrate **11** and a peripheral circuit **12**. The substrate **11** can be, for example, a transparent plastic substrate or a transparent glass substrate. In addition, the substrate **11** can also be a polyethylene terephthalate (PET) thin film substrate or other thin film-shaped substrates. The substrate **11** has an outer surface **S1** and an inner surface **S2**. The user usually views the touch panel **1** from the outer surface S**1** side, and performs various kinds of operations on the outer surface S**1**. Other structures and elements of the touch panel **1** are disposed on the inner surface S**2** side of the substrate **11**.

The inner surface S**2** of the substrate **11** includes a transparent conductive pattern **111**, a masking decoration layer **112** and a conductive layer **113**. The transparent conductive pattern **111**, disposed on the inner surface S**2** of the substrate **11**, is utilized for defining a touch sensing circuit. The material of the transparent conductive pattern **111** can be, for example, indium tin oxide (ITO). The masking decoration layer **112** is disposed next to a terminal of the transparent conductive pattern **111**, and the material of the masking decoration layer **112** can be, for example, an insulating material or insulating ink with various colors. The conductive layer **113** is disposed on the masking decoration layer **112** and the transparent conductive pattern **111**, and extends from a terminal of the transparent conductive pattern **111** to the masking decoration layer **112**. The material of the conductive layer **113** includes a transparent high molecular conductive material or ITO, and the conductive layer **113** may be formed on the masking decoration layer **112** and the transparent conductive pattern **111** by printing.

The peripheral circuit **12** is disposed on the conductive layer **113** and the masking decoration layer **112**, and extends to the conductive layer **113** without exceeding an edge of the masking decoration layer **112**. In other words, projection of the peripheral circuit **12** is located on the masking decoration layer **112**, or is flush with the edge of the masking decoration layer **112**. The material of the peripheral circuit **12** is a radiation curable conductive material, which can be, for example, radiation curable silver glue, radiation curable silver paste or radiation curable ink. Fine circuits of the peripheral circuit **12** are defined by using screen printing equipment together with a screen with fine wires, and are formed on the transparent conductive pattern **111** and the masking decoration layer **112** by printing. Please note that, in the above process, the radiation curable conductive material may preferably be disposed as block-shaped circuits on the substrate printed directly by the printing equipment. In this process, no fine wire mesh needs to be utilized, and the printed block-shaped circuits may further be utilized for forming finer circuits in cooperation with lithography technique. Such implementation allows the wire width of the peripheral circuit **12** to be less than or equal to 70 micrometers, and reduces the requirements for high precision screens, which favors cost reduction and quality enhancement. The following paragraphs will detail how to cooperate with the lithography technique, and the photolithography technique in particular.

The above radiation curable conductive material is not limited to be composed of some special elements. The radiation curable conductive can be a material which has a certain conductivity and will be dried or cured after being irradiated by a short wavelength radiated ray. Specifically, the radiation curable conductive material can be an ultraviolet radiation cured conductive material or an ultraviolet radiation dried conductive material, which is liquid or adherent when printed, where parts of the material which are irradiated by the ultraviolet radiation will be dried or cured immediately and adhered to the substrate. The non-irradiated parts will still be liquid or adherent, and can be removed easily. In addition, conductive materials which are dried or cured when irradiated by radiated rays with other wavelengths may also be utilized. The above is therefore not limited to ultraviolet radiation.

As shown in FIG. **1**B, the touch panel **1** may further include an insulating layer **13** and a conductive adhesive **14**. The insulating layer **13** covers parts of the peripheral circuit **12** by screen printing, in order to prevent the peripheral circuit **12** from being oxidized due to exposure to the air. The conductive adhesive **14** is adhered to the peripheral circuit **12** and a pin P of a flexible printed circuit board (FPC), such that the touch sensing signals generated by the transparent conductive pattern **111** can be transmitted to the pin P of the FPC via the conductive layer **113**, the peripheral circuit **12** and the conductive adhesive **14**. In other embodiments, the conductive adhesive **14** may be an anisotropic conductive film (ACF) or anisotropic conductive paste (ACP). When the touch panel is applied, the insulating layer may also be ignored, which is not limited herein.

Please note that the transparent conductive pattern **111** in this embodiment is formed on the substrate **11** directly, and the substrate **11** belongs to a type having touch sensing functions and a cover plate simultaneously. The application is not limited to this, and various types of touch panels can be applied according to the present invention. For example, a substrate with a two-layer structure composed of two substrates may also be applied in the present invention, where the top layer substrate and the bottom layer substrate both possess the transparent conductive pattern.

Please refer to FIG. **2**A and FIG. **2**B, which are schematic diagrams of another touch panel **2** according to a preferable embodiment of the present invention. The touch panel **2** includes a substrate **21** and a peripheral circuit **22**. The substrate **21** can be a transparent substrate, which can be, for example, a plastic substrate or a glass substrate. The substrate **21** may also be other types such as a PET thin film substrate or other thin film-shaped substrates. The user usually views the touch panel **2** from the outer surface S**1** side of the substrate **21** and performs various kinds of operations on the outer surface S**1**. Other structures and elements of the touch panel **2** are disposed on the inner surface S**2** side of the substrate **21**.

The inner surface S**2** of the substrate **21** includes a transparent conductive pattern **211**, a masking decoration layer **212** and a conductive layer **213**. The transparent conductive pattern **211** is utilized for defining a touch sensing circuit. The material of the transparent conductive pattern **211** can be, for example, ITO. The conductive layer **213** is disposed on the substrate **21**, and extends to a terminal of the transparent conductive pattern **211** to cover parts of the transparent conductive pattern **211**. The masking decoration layer **212** is disposed on the substrate **21** and the conductive layer **213** and extends to the conductive layer **213**. The masking decoration layer **212** possesses an opening H on the conductive layer **213**, where the masking decoration layer **212** is disposed without exceeding an edge of the conductive layer **213**.

The material of the conductive layer **213** includes conductive carbon paste, and the material of the masking decoration layer **212** can be, for example, an insulating material or insulating ink with various colors. For color selection of the masking decoration layer **212**, a color similar to that of the conductive layer **213** is preferably selected to be utilized, such that the user may not feel the difference of color between the masking decoration layer **212** and the conductive layer **213** when viewing the outer surface S**1** of the touch panel **2**. In addition, the conductive layer **213** and the masking decoration layer **212** may be formed on the substrate **21** by printing.

The peripheral circuit **22** is disposed on the masking decoration layer **212**, and a part of the peripheral circuit **22** is filled in the opening H and coupled to the conductive layer **213**. The material of the peripheral circuit **22** is a radiation curable conductive material, which can be, for example, radiation curable silver glue, radiation curable silver paste or radiation curable ink. The peripheral circuit **12** is formed on the masking decoration layer **212** by printing and irradiating of a radiated ray.

As shown in FIG. **2**B, the touch panel **2** further includes an insulating layer **23** and a conductive adhesive **24**. The insulating layer **23** is disposed on the peripheral circuit **22**, in order to prevent the peripheral circuit **22** from being oxidized due to exposure to the air. The conductive adhesive **24** is adhered to the peripheral circuit **22** and a pin P of an FPC. The pin P is coupled to the conductive layer **213** via the conductive adhesive **24** and the peripheral circuit **22**, in order to receive the touch sensing signals generated by the transparent conductive pattern **211**, where the conductive adhesive **24** can be ACF or ACP. In other embodiments, the insulating layer may also be ignored, which is not limited herein.

Please refer to the block diagram shown in FIG. **3** together with FIG. **1**A, which illustrates a method of manufacturing the peripheral circuit of the touch panel according to a preferable embodiment of the present invention. This method can be applied for manufacturing the abovementioned peripheral circuit **12** of the touch panel **1**. The steps of the manufacturing method include Steps S**31**-S**33**.

Step S**31** is printing a radiation curable conductive material on the substrate **11** having the transparent conductive pattern **111**. For the implementation of Step S**31**, at least two methods may be included. One of the methods is forming the radiation curable conductive material on the transparent conductive pattern **111** and the masking decoration layer **112** of the substrate **11** by printing (especially screen printing) by using screen printing equipment in cooperation with a fine wire mesh, wherein the fine wires printed on the radiation curable conductive material are processed by follow-up radiation, in order to form the finer peripheral circuit **12**. The second preferable method is printing the radiation curable conductive material on the substrate **11** directly by blocks or areas where the fine wire mesh is not utilized, and the follow-up operations are then performed on the formed pattern, in order to form a plurality of wires of the peripheral circuit **12**.

The abovementioned radiation curable conductive material can be radiation curable silver glue, radiation curable silver paste or radiation curable ink. The substrate **11** is a transparent substrate, which can be, for example, a plastic substrate or a glass substrate. In other cases, the substrate **11** may also be PET thin film substrate or other thin film-shaped substrates. The material of the transparent conductive pattern **111** can be, for example, ITO, and the material of the masking decoration layer **112** can be, for example, an insulating material or insulating ink with various colors. The transparent conductive pattern **111** may first be formed on the substrate **11** by sputtering and etching, and the masking decoration layer **112** may be disposed on the substrate **11** by deposition or printing according to its material.

Step S**32** is irradiating the radiation curable conductive material with a radiated ray, in order to cure parts of the radiation curable conductive material. For the implementation of Step S**32**, the radiation curable conductive material is irradiated by a radiated ray having a wavelength within a range from 230 nanometers to 600 nanometers. In order to regulate the position of the circuit layout, the method for curing parts of the radiation curable conductive material is performed by disposing a photomask on the radiation curable conductive material, which allows the radiated ray to cure the radiation curable conductive material selectively according to product requirements or circuit designs. The material of the above photomask includes glass, quartz or PET, and the form of photomask can be, but is not limited to, positive or negative, which is determined according to the nature of the material and the structural requirements of the peripheral circuit **12**.

In order to enhance the integration of the radiation curable conductive material connected with the transparent conductive pattern **111** and the masking decoration layer **112**, and accelerate the speed for curing the radiation curable conductive material, the radiated ray may irradiate the radiation curable conductive material in at least two phases. During these two phases of irradiation, the radiated ray may have two different wavelength ranges. For example, the radiation curable conductive material may first be irradiated by the radiated ray with a wavelength range from 300 nanometers to 400 nanometers, and then be irradiated by the radiated ray with a wavelength range from 230 nanometers to 600 nanometers. Please note that the above wavelength ranges are only an exemplary illustration, and are not utilized for limiting the present invention.

Step S**33** is removing uncured parts of the radiation curable conductive material, in order to form the peripheral circuit **12**. For the implementation of Step S**33**, the uncured parts of the radiation curable conductive material may be removed by, for example, pure water, such that the peripheral circuit **12** can be formed by the cured parts of the radiation curable conductive material. The peripheral circuit **12** is connected with the transparent conductive pattern **111**, and transmits the touch sensing signals generated by the transparent conductive pattern **111** to an FPC. Since printing and parts of the photolithography process are integrated according to the present invention, the peripheral circuit **12** can be manufactured in an easy and low cost way, and the formed wire width can be less than or equal to about 70 micrometers, which enhances the integration. The utilization of a large number of chemicals is excluded in the present invention, which not only simplifies the process significantly, but also complies with environmental protection and power saving.

The peripheral circuit **22** of the other touch panel **2** provided by the present invention may also be manufactured by the above methods, and both the structure characteristics and the process can be known by referring to the above illustration. These will not be narrated herein.

The above peripheral circuit of the touch panel and the manufacturing method thereof according to the present invention utilizes radiation curable conductive material as a printing material to be printed on the substrate, cures parts of the radiation curable conductive material, and then removes uncured parts of the radiation curable conductive material in order to form the peripheral circuit, which realizes the reduction of wire width or wire distance in order to achieve higher integration while complying with environmental protection requirements. In addition to utilizing the radiation cured material as the above conductive material, other types of conductive materials may also be realized. What follows is an embodiment utilizing a photosensitive material as the conductive material, which is cured by a visible light in order to form the peripheral circuit.

Please refer to FIG. **4**A, which is a schematic diagram of a further touch panel **4** according to a preferable embodiment of the present invention. The touch panel **4** includes a substrate **41** and a peripheral circuit **42**. The substrate **41** is a transparent substrate, which can be, for example, a plastic substrate or a glass substrate. In other embodiments, the substrate **41** may also be a thin film-shaped substrate such as a PET thin film, etc. In order to take advantage of the exposure and development process in which a high temperature baking process is not required, the substrate **41** can preferably be a thin film substrate having flexibility, which is called a flexible substrate, but is not limited herein.

The substrate **41** has an outer surface S1 and an inner surface S2. The user usually views the touch panel **4** from the outer surface S1 side of the substrate **41**, and performs various kinds of operations on the outer surface S1. Other structures and elements of the touch panel **4** are disposed on the inner surface S2 side of the substrate **41**. In this embodiment, the inner surface S2 of the substrate **41** includes a transparent conductive layer **411**. The transparent conductive layer **411** is utilized for defining a touch sensing circuit, and the material of the transparent conductive layer **411** can be, for example, ITO.

The peripheral circuit **42** is disposed on the inner surface S2 of the substrate **41**, and is placed next to a terminal of the transparent conductive layer **411** by screen printing. The material of the peripheral circuit **42** is a photosensitive conductive material, which includes a photosensitive resin composition and a plurality of silver particles. For the implementation of the peripheral circuit **42**, a diameter of the silver particles is within a range from 1 micrometer to 10 micrometers, and more preferably, within a smaller range from 1 micrometer to 5 micrometers; it may also be blended with several nanometer silver particles. In addition, the photosensitive resin composition is a material which may react after being irradiated by a light.

As shown in FIG. **4**B, the touch panel **4** may further include an insulating layer **43**, a conductive adhesive **44** and an FPC **45**. The insulating layer **43** is formed on parts of the peripheral circuit **42** by pasting or printing, in order to prevent the peripheral circuit **42** from being oxidized due to exposure to the air. The color of the insulating layer **43** may also be selected according to product requirements, which allows the insulating layer **43** to be a decoration layer simultaneously. The conductive adhesive **44** is adhered to the peripheral circuit **42** and a pin **451** of the FPC **45**, such that the touch sensing signals generated by the transparent conductive layer **411** can be transmitted to the pin **451** of the FPC **45** via the peripheral circuit **42** and the conductive adhesive **44**. In some embodiments, the conductive adhesive **44** can be ACF or ACP.

Please note that, in this embodiment, the transparent conductive layer **411** is formed on the substrate **41** directly and provides touch sensing functions independently; hence the substrate **41** in this embodiment belongs to a type having touch sensing functions and a cover plate simultaneously. According to the present invention, a two-layer touch panel **4***c* with a two-layer structure may also be utilized, where the two-layer touch panel **4***c* is composed of two substrates **41**, as illustrated in FIG. **4**C. The following paragraphs illustrate that the above substrate **41** with one-layer structure includes multiple functions.

After the assembly process of the substrate **41** is accomplished, only the outer surface S1 of the substrate **41** is exposed to the outside, and the transparent conductive layer **411**, the peripheral circuit **42** and other structures are covered by the substrate **41**. In such a condition, the substrate **41** not only can provide decoration functions and cover these elements such as the peripheral circuit **42**, etc., but can also protect the peripheral circuit **42** and the transparent conductive layer **411** from damages. Moreover, the complete transparent conductive layer **411** is disposed on the substrate **41**, which is enough to provide sensing functions. Therefore, the present invention realizes both the simplification of substrate process and the diversification of functions. This prospective creation of the distinguishing features is suitable for a modular process to benefit from cost reduction.

Please keep referring to FIG. **4**D. A touch panel **4***d* is substantially the same as the above touch panel **4** shown in FIG. **4**B, and the only difference is that the touch panel **4***d* further includes a protective film **46**. The protective film **46** may be formed on the peripheral circuit **42** and the transparent conductive layer **411** by pasting or printing, in order to cover these two elements and provide protection and decoration functions. The protective film **46** can be adhered to the substrate **41** stably by adding an optical clear adhesive (OCA) **47**.

Please refer to the block diagram shown in FIG. **5** together with FIG. **4**A, which illustrates a method of manufacturing the peripheral circuit of the touch panel according to a preferable embodiment of the present invention. This method can be applied for manufacturing the abovementioned peripheral circuit **42** of the touch panel **4**. The steps of the manufacturing method include Steps S**51**-S**54**.

Step S**51** is printing a photosensitive conductive material on the substrate **41** by screen printing. As shown in FIG. **6**A, for the implementation of Step S**51**, a photosensitive conductive material **63** is formed on the transparent conductive layer **411** of the substrate **41** by printing via screen printing equipment composed of a scraper **61** and a screen **62**. In detail, the screen printing equipment prints the photosensitive conductive material **63** on the substrate **41** by blocks or areas.

The above photosensitive conductive material **63** includes a photosensitive resin composition and a plurality of silver particles. A diameter of the silver particles is within a range from 1 micrometer to 10 micrometers, and more preferably within a range from 1 micrometer to 5 micrometers. The substrate **41** is a transparent substrate, which can be, for example, a plastic substrate or a glass substrate. The material of the transparent conductive layer **411** can be, for example, ITO. The transparent conductive layer **411** may first be formed on the substrate **41** by sputtering and etching.

Step S**52** is disposing a photomask **64** on the photosensitive conductive material. In order to regulate the position of the circuit layout, the photomask **64** is disposed on the photosensitive conductive material **63** for the implementation of Step S**52**, as illustrated in FIG. **6**B. The material of the above photomask includes glass, quartz or PET, and the form of the photomask **64** can be, but is not limited to, positive or negative, which is determined according to the nature of the material and the structural requirements of the peripheral circuit **42**.

Step S**53** is irradiating the photosensitive conductive material with a beam **65**, in order to cure parts of the photosensitive conductive material. For the implementation of Step S**53**, a light wave generation apparatus is utilized for generating the beam **65**, which selectively irradiates the photosensitive conductive material **63** via the photomask **64**, as illustrated in FIG. **6**B. The beam **65** can be, for example, a visible light, which has a wavelength within a range from 350 nanometers to 780 nanometers.

Step S**54** is etching uncured parts of the photosensitive conductive material, in order to form the peripheral circuit **42**. For the implementation of Step S**54**, for example, developer may be utilized for etching the uncured parts of the photosensitive conductive material, in order to remove the uncured parts of the photosensitive conductive material and form the peripheral circuit **42** with the cured parts of the photosensitive conductive material. The peripheral circuit **42** is connected with the transparent conductive layer **411**, wherein a wire width of the peripheral circuit **42** may be less than 100 micrometers and a wire distance of the peripheral circuit **42** may be less than 120 micrometers.

Please refer to FIG. **4**D. In this structure, the method of manufacturing the peripheral circuit of the touch panel **4***d* further includes: adhering the peripheral circuit **42** to the FPC **45** by using the conductive adhesive **44**, and disposing the protective film **46** on the peripheral circuit **42**. For the implementation of these steps, the protective film **46** may be formed on parts of the peripheral circuit **42** and the transparent conductive layer **411** by pasting or printing, in order to prevent the peripheral circuit **42** from being touched or oxidized due to exposure to the air directly. The color of the protective film **46** may also be selected according to product requirements, which allows the protective film **46** to be a decoration layer simultaneously, in order to prevent the user from viewing the inside circuits.

The conductive adhesive **44** is adhered to the peripheral circuit **42** and the pin **451** of the FPC **45**, such that the touch sensing signals generated by the transparent conductive layer **411** can be transmitted to the pin **451** of the FPC **45** via the peripheral circuit **42** and the conductive adhesive **44**. In some embodiments, the conductive adhesive **44** can be ACF or ACP.

The above peripheral circuit of the touch panel and the manufacturing method thereof according to the present invention utilizes photosensitive conductive material as a printing material to be printed on the substrate, cures parts of the photosensitive conductive material, and then etches uncured parts of the photosensitive conductive material in order to form the peripheral circuit, which realizes the simplification of the manufacturing process while retaining the adherence degree and electronic characteristic.

In summary, the peripheral circuit of the touch panel and the manufacturing method thereof according to the present invention enjoy the benefits of screen printing and exposure/development, ensuring that not only can the touch panel be manufactured at a low cost and high speed, but that the touch panel is also provided with the advantages of small wire width and wire distance. Therefore, this method is suitable for smaller electronic devices, while overcoming the barriers of the conventional processes. The method of manufacturing the peripheral circuit of the touch panel utilizing a printing technique according to the present invention can minimize the wire width and the wire distance of the peripheral circuit, in order to achieve a fine wire width process to enhance the resolution. The peripheral circuit of the touch panel and the manufacturing method thereof according to the present invention can also enlarge the visible area, which provides greater convenience to the user. For the implementation of the present invention, the manufacturing method enjoys the benefits of screen printing and exposure/development; hence power consumption problems can be avoided, as opposed to the conventional thermal curing process where the power consumption is generated by using an oven for a long time. Therefore, the environmental protection requirements can also be met.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A touch panel, comprising:

a substrate, having a transparent conductive pattern;

a peripheral circuit, connected with the transparent conductive pattern; and

a masking decoration layer, disposed next to a terminal of the transparent conductive pattern;

wherein the peripheral circuit is behind the entire masking decoration layer;

wherein the peripheral circuit comprises cured parts of a radiation curable conductive material.

2. The touch panel of claim **1**, wherein a wire width of the peripheral circuit is less than or equal to about 70 micrometers.

3. The touch panel of claim **1**, wherein the radiation curable conductive material comprises radiation curable silver glue, radiation curable silver paste or radiation curable ink.

4. The touch panel of claim **1**, wherein the substrate is a transparent plastic substrate, a transparent glass substrate or a PET thin film substrate.

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